ADMINISTRATIVE INFORMATION

1. **Project Name:** Boiler and Furnace Efficiency Improvement with Low-Cost CO Sensor and Burner Control System (CPS# 14229)

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5. **Date Project Initiated:** March 1, 2004

6. **Expected Completion Date:** September 30, 2007

PROJECT RATIONALE AND STRATEGY

7. **Project Objective:**

This project will develop, demonstrate and commercialize a low-cost sensor and control system for increasing boiler and furnace efficiency by reducing excess oxygen in combustion air. The key component being developed is an in-situ, non-extractive CO sensor, positioned in the stack, that uses a CO emission source to allow detection of stack CO concentrations with a high signal to noise ratio. The CO measurement will be fed to a burner control using neural network logic that selects burner response rates and settings based on stack conditions and prior performance for comparable load and transient conditions.

8. **Technical Barrier(s) Being Addressed:** .

For a low-cost control system with rapid payback, the CO sensor must be in-situ, non-extractive, low maintenance and accurate. This requires self calibration and relative freedom from interference from other combustion gas constituents. The control system must be capable of selecting an optimum, safe 02-CO that gives substantial reduction in energy consumption over the load ranges, fuel variability, and load-following transient conditions experienced with the boiler/furnace.

9. **Project Pathway:**

The key innovation in the in-situ non-extractive sensor development is to use a CO emission source to generate a signal that can be processed to give a high CO spectra that can be compared to spectra

in the path length across the flue gas stack. This comparison gives self calibration of the sensor and provides a real-time measurement with high signal-to-noise ratio over a short path length. It also avoids interference problems characteristic of cell technologies. The burner control system will be programmed with fuzzy logic neural network algorithms that learn emission response for each load setting and burner position at both steady state and transient conditions. The control system will perturb the burner control loop to trim the excess air to the knee of the CO – O2 response curve.

10. **Critical Technical Metrics.**

Industrial boilers in the 25,000 lb/hr to 100,000 lb/hr capacity typically operate at 15% – 25% excess air level. The optimum excess air level prior to causing CO excursions is in the 7% to 10 % range. For theses smaller capacity boilers, the control system is intended to reduce excess air by 5% to 15%, which will result in an efficiency gain of 0.5% to 0.75%. Larger industrial boilers typically offer smaller incremental percentage improvements because they have more complex controls, but offer larger total energy savings because of larger unit capacities. Boilers in the 200,000 lb.hr to 500,000 lb/hr range typically operate in the 10% - 15% excess air range. The optimum excess air level prior to onset of CO increases is around 7%, giving an excess air reduction of 3% to 8% with the use of the sensor-control system. This gives about a 0.3% efficiency improvement.

PROJECT PLANS AND PROGRESS

11. **Past Accomplishments:** Not applicable; project just being initiated in FY04.

12. **Future Plans:**
- Develop bench-scale test facility to refine the CO sensor concept (February 2005)
- Develop burner control algorithm for boiler and furnace applications (March 2005)
- Conduct developmental testing of integrated sensor-control system over a range of oxygen levels, CO levels, duct size, flue gas temperature, and transient rates of concentration and temperature excursions. (December 2005)
- Develop prototype system design (March 2006)
- Install and test system on the boiler at the State of California Central Plant Operations (February 2007)
- Develop commercialization plan for marketing to boiler and process furnace industry (June 2007)

13. **Project Changes:** None

14. **Commercialization Potential, Plans, and Activities:** .

The result of the project will be a packaged CO sensor and burner control system with applicability to a wide range of boiler designs and capacities from 20,000 lb/hr to over 500,000 lb/hr, and to industrial process furnaces where excess air reduction is feasible. The unit will be priced to achieve a targeted payback of less than one year. The potential addressable market of installed equipment is over 70,000 existing boiler or furnace units as well as new boiler/furnace installations. Coen Company will manufacture and market the system and will develop the following market pathways"
- Direct sales to boiler and furnace operators by the Coen representative sales network
- Alliances with boiler and furnace OEM's for new equipment and after-market sales
- Alliances with control system vendors, equipment installers and field service engineers to include the CO control into larger equipment or service packages

15. **Patents, Publications, Presentations:**

Patent pending on the CO sensor concept by Coen Company